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ECONOMY IN THE UTILISATION OF WATER

By Oscar BENASSINI,
Engineer,
Head of Projects
and Planning Department

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ECONOMY IN THE UTILISATION OF WATER.

by Eng. Oscar BENASSINI.
Head of Projects and Planning Department.

1. Preamble

The general configuration of the Mexican Republic is such as to be unfavourable to the existence of large rivers of steady volume such as there are in other continental regions. Actually, the long narrow shape of the country, and its high ranges of mountains running down its length, result in the rivers being short, with steep gradients and narrow collecting basins. These factors, added to irregular rainfall confined mostly to a few months of the year, Mexico's situation in the tracks of cyclones, plus the absence of snow, all contrive to ensure that the rivers are essentially of torrential type, and, consequently, difficult to make use of in their natural state.

In the high Mexican plateaux there are no large rivers and it is only in the coastal regions bordering the Pacific Ocean and the Gulf of Mexico that there are rivers of any importance. The only ones worth considering, are in the South-Eastern region drained by the Papaloapan, Coatzacoalcos, Tonala, Grijalva and Usumacinta rivers.

The average annual volume of water brought down by the Mexican rivers amounts to 357,257 million cu. m. of which 211,232 million cu. m., say some 60%, come from seven large rivers draining a total area of 450,000 sq. km., that is 23% of the country's total surface area.

On the other hand, it is estimated that the annual infiltration of water into the soil in Mexico reaches a volume of more than 270,000 million cu. m., part of which can be recovered by well pumps.

More than 80% of the water used in Mexico comes from surface supply, with the balance from subterranean sources.

2. Distribution of water resources

At first sight it would appear that Mexico has no serious problems of water shortage, since it possesses within its territory resources which would be sufficient fully to satisfy its present and future demands, if they were used in a rational manner based on careful planning. However, the irregular regional distribution of population and natural resources prevents their co-ordinated use on a national scale to the best advantage.

The five large rivers of the South-East bring down 174,967 million cu. m., that is about 50% of the surface water resources of Mexico, and they drain an area of only 164,600 sq. km., which is about 8% of the national territory, whilst more than half of the country suffers from a shortage of water. This group of river basins , so favourably endowed as regards the national water resources, is inhabited by 3 million persons, that is to say, 9% of the population enjoys 50% of

the water resources. The Bolson de Mapimi and El Salado, which between them cover an area of 144,800 sq. km., equal to more than 7% of the country's surface have no rivers above ground worth taking into consideration as a natural resource.

Taking into account the total volume of water in all the country's rivers, the amount available is equivalent to an average of 10,428 cu. m. annually per inhabitant (see Table), which is 8 times as much as that required for a man to satisfy all his water needs in a temperate climate. But, when one comes to consider each region separately, serious shortages are found in some of them, which means that water has to be piped from neighbouring regions, water wells are in use, and restrictions put a brake on regional development. In other cases there are large surpluses of water which are difficult to make use of and this also hampers development.

In the thinly populated Southern Gulf region, drained by the rivers Coatzacoalcos and Tonala, the amount of water available per head reaches 110,123 cu. m. per annum. In the river basins of the Grijalva-Usumacinta system and the Papaloapan, there are available 79,697 and 28,966 cu. m. respectively per inhabitant per annum.

By contrast, in El Bolson de Mapimi and El Salado, 790,000 inhabitants rely precariously on water supplies from subterranean sources. In the Mexico Valley, seat of the Capital, with its dense conurbation of 5,680,000 people, the water available per person is barely 64 cu. m. per annum. To supplement this supply it has been necessary to bring water from adjacent river basins, make intensive use of underground water, to bring in agricultural produce from neighbouring districts and to import electric power from more favoured regions.

Other regions can rely on a sufficient supply of water but this is badly spread out both spatially and seasonably and it is therefore necessary in those areas to have recourse to piped water and underground supplies, and eke them out by drawing on the resources of more favoured regions.

In those regions where the natural water supply is deficient and demand high, recourse is had to conservation, re-use, staging of river dams, priorities according to productive use and in general, to all methods designed to ensure optimum and the fullest use of the water available. Where supplies are abundant or demand is low, there has been no necessity to enforce conservation.

3. Staging of river dams for different uses of water

The present plan for full and equitable utilisation of the water resources of each hydrographical basin covers river control and schemes for re-use of river water depending on purpose, such as for production of hydro-electric power, supply of water to centres of population for domestic, commercial, industrial and municipal needs, irrigation, industrial use outside urban centres, navigation, cultivation and use of aquatic fauna, sport, control of sedimentation, etc. Provision is also made for essential flood defence works, channelling, drainage

AVAILABLE WATER SUPPLIES IN REGIONS OF THE MEXICAN REPUBLIC.

	Region	Areas in m.hectares	Total flow m. cub. m.	Population in m's.	Supply per head in cub. ms.
	WHOLE COUNTRY	196.39	357,257	34.26	10,428
1	Lower California N.	6.76	312	0.24	1,300
2	Lower California S.	7.36	262	0.08	3,275
3	Rio Colorado	0.44	1,850	0.32	5,781
4	Northwest	33.06	28,858	1.82	15,856
5	Lerma-Chapala-Santiago	12,66	11,457	5.75	1,993
6	Central Pacific	6.20	11,333	0.91	12,454
7	Rio Balsas Basin	10.96	12,186	3.52	3,462
8	South Pacific	9.00	50,116	1.99	25,184
9	Rio Breve Basin	24.03	4,780	2.68	1,784
10	Northern Gulf	5.01	3,473	0.25	13,892
11	Rio Panuco Basin	7.44	18,860	2.11	8,938
12	Central Gulf	3.90	28,098	1.98	14,191
13	Papaloapan Basin	4.66	41,135	1.42	28,968
14	Southern Gulf	3.16	28,632	0.26	110,123
15	Grijalva-Usumacinta	8.64	105,200	1.32	79,697
16	Yucatan Peninsula	13.54	5,811	0.82	7,087
17	Closed North Basins N.Zone	10.35	856	0.20	4,280
18	Bolson de Mapimi	5.60	+++	0.01	+++
19	Closed N. Basins S.Zone	10.86	1,592	0.98	1,624
20	El Salado	8.88	+++	0.78	+++
21	Durango	1.78	711	0.30	2,370
22	Cuitzco & Patzcuero	0.65	413	0.47	879
23	Mexico Valley	0.74	362	5.68	64
24	Metztitlan Valley	0.28	740	0.16	4,625
25	Eastern Valley, Libres & ElSeco	0.43	220	0.21	1,048

+ Surface water supplies are practically NIL

and run off etc. And so engineering schemes generally aim at solving the greatest number of problems with each dam built, so as to obtain from the water and from the installations themselves every possible benefit and thus obtain supply facilities which would be far too expensive if they were limited to only one purpose, be it irrigation, generation of electric power or defence against floods. These public works are economically very attractive if they serve several purposes simultaneously.

The order in which the schemes are arranged downriver varies in accordance with the available supplies and the requirements of each region. In general, those which do not use up or contaminate the water come first; those which consume water come next; and those which contaminate the water come last. In the case of a series of supply installations laid out throughout the length of a river basin, protective measures are taken to make sure that any contaminated water is passed through treatment plants before being discharged into the river again for further use lower down.

In the upper reaches of the river basin where advantage can be taken of differences in levels, hydro-electric dams are installed, which help control flow; so, too, are a number of industrial plants. Subsequently, after the river has been fed by the water from further tributaries and is now flowing through agricultural land, its water is taken for irrigation, which is singularly important in a country like Mexico where the greater part of the territory lacks the natural moisture needed for the development of agriculture without irrigation. Water is also taken at this stage for the development of pasture land to support a very large number of cattle. Finally, water is supplied for such purposes as may lead to its being contaminated to such a degree that it can no longer be used again. The supply of water to centres of population must have preference, according to our legal enactments, over all other kinds of water supply, and this is seen to at every stage in relation to necessity and demand.

4. Measures to reduce losses from evaporation and filtration from reservoirs

The treatment applied to cement work in the dams, by means of screens formed by deep injections of cement grout, practically eliminates loss of water by filtration in the feed reservoirs. On the other hand, losses by evaporation are very large, but it has not been considered necessary to take measures to avoid this, because of the great expense involved in doing so, and because a whole series of measures would have to be taken to conserve water downriver.

5. Underground Supplies

In the arid regions of North Mexico, where surface water is very scarce, large schemes have been carried out to obtain water from underground sources in addition to surface water, as in the Valle de Mexicali and the Lakes Region, or from underground sources exclusively, as on the Costa de Hermosillo, Caboraca etc. Actually, in some parts of the North there is over-exploitation of the water-bearing holes, that is to say that more water is being taken out than flows in again. These water holes are in some cases treated as a non-renewable supply,

which will finally dry up, or at best, only able to be used after a period of very heavy rain, in which the holes fill up again. This is the case with some water holes situated in El Bolson de Mapimi and in the El Salado Region.

At the present moment, preliminary studies for underground storage of water in the arid zones are going on, the idea being to store by infiltration, surface flood water, which would otherwise be lost. In other regions, which are over populated, particularly the Mexico Valley, success has been achieved in replenishing the water table by means of absorption wells, through which rain water passes.

6. Reduction of Conduction Losses

At present, practically all conduit channels and distribution pipes for irrigation water are being lined in the first place to reduce losses in conduits etc., and, secondly, to reduce the amount of excavation required, to reduce the cost of storing, to reduce the amount of run-off water, to stop the growth of weeds, to give security against pipe-bursts, to eliminate erosion, to reduce the cost of buildings and to reduce to a minimum unauthorised diversion. In some cases, one of these factors alone would justify re-lining the conduits.

According to investigations carried out on a large number of irrigation channels, not lined, losses in conduction, from the supply source to the land which benefits, vary between 35% and 50%, which means that, from this cause alone, the effectiveness of supply is reduced to one half. Lining conduits not only reduces losses of water obtained with great trouble and large investments of money, but also avoids the loss of large areas of land in the vicinity of the channels where marshland is formed, difficult to drain and useless for agricultural purposes.

Conduits are generally lined with concrete or masonry, according to the special conditions of each case. Lining reduces pipe losses by some 10 to 12%, making it possible to increase the area of irrigation by no less than 30%. The money required for lining is justified, in most cases, by this increase in irrigation area, thus making these projects more attractive economically.

In the existing irrigation systems, improvement plans include, in the first place the lining of channels as a means of improving the supply of water and drainage conditions. This does not signify an increase in the areas of irrigation but a bigger supply of water for the areas which are already in production so as to promote the essential diversification of crops, which requires a higher co-efficient of irrigation.

In the areas which are being irrigated in the arid zones, by means of water pumped from underground, plans are being made for lining the distributing systems, to reduce losses and so reduce the quantity of water to be pumped, with the double purpose of reducing cost of production and also improving conditions for the replenishment of the water table. These plans do not include an extension of the areas under irrigation.

7. Improvements in irrigation methods to reduce losses of water

The most effective methods which have been put into practice for reducing loss of water intended for irrigation, are levelling the terrain and shortening the length of furrows to not more than 200 m., depending upon the nature of the soil, with the triple objective of increasing production, reducing amount of water used and washing out salts.

By shortening the length of his furrows, the farmer can control the excess of "end" water, since the volume of water lost is in direct proportion to the length of the furrows.

These measures are in common use in the large irrigation areas in the arid zones, and steps are being taken to extend their use to the other irrigation zones in the country. It should be made clear that these plans for saving water locally are being carried out by government initiative, but with the invaluable help of the users, who are convinced of the necessity of preserving this precious source of supply for their own benefit.

8. Re-use of return water

On rivers which are used for manifold purposes throughout their length, the return and excess water from the first installation are used to advantage in the succeeding installations, always provided that there has not been any contamination which has rendered them useless.

On rivers like the Lerma and the Balsas, which have a long course from the Sierras down to their mouths, there are many stages of supply installations, which utilise very effectively return and excess water.

In the large irrigation areas, generally situated in the lower reaches of the rivers, return water is generally impounded by drainage and discharged outside the zone.

The measures which are being taken to reduce to a minimum water losses in irrigation districts, both during conduction and distribution to farmers' plots will tend to a reduction of return water.

9. Measures to avoid contamination of water

The application of measures to avoid artificial contamination of water has only recently begun. No need for the application of restrictive measures had been felt, as it looked as if this was not a problem in Mexico.

At the present moment, there is frequent contamination of water, rendering it useless, and protective measures are beginning to be applied, taking, as their first consideration, the placing of water supply installations along the whole course of the rivers in stages so as to neutralize this danger. However, contamination caused by discharges from the drainage systems of towns is very extensive, and this danger increases in the low-water months when the volume of the rivers is down to a minimum. In order to combat this danger, it is

now usual to use treatment plants, which allow of water being discharged practically free of contamination. The next step will be the use of organic matter and the final objective is the re-circulation of water, in those zones where the supply is small.

10. Re-circulation of water

The process of water re-circulation is limited almost exclusively to industrial uses in the large cities, and is, in general applied to underground water obtained by the industry itself for use in cooling or in its production processes. In the city of Mexico, supplies of this kind of water have also been provided for recreational purposes. Although plans exist for the supply of this surplus water in various cities, after treatment, this has been considered unjustifiable owing to the large amounts of capital which would have to be sunk in such projects.

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